YAMAHA
YAMAHA MOTOR CO., LTD.

YAMAHA SINGLE-AXIS ROBOT FLIP-X series Pico type

T4P/T5P

User's Manual

ENGLISH E

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Introduction

This manual describes the safety measures, handling, adjustment and maintenance of YAMAHA Pico series robots for correct, safe and effective use. Be sure to read this manual carefully before installing the Pico series robot. Even after you have read this manual, keep it in a safe and convenient place for future reference when needed.

This instruction manual should be used with the robot and considered an integral part of it. When the robot is moved, transferred or sold, send this manual to the new user along with the robot. Be sure to explain to the new user the need to read through this manual.

Specifications of robot models other than standard models may be omitted in this manual if they are common to those of standard models. In this case, refer to the specifications of standard models.

For details on specific operation and programming of the robot, refer to the separate "PRC Single-axis Robot Controller User's Manual".

NOTES

- The contents of this manual are subject to change without prior notice.
- Information furnished by YAMAHA in this manual is believed to be reliable. However, if you find any part unclear or inaccurate in this manual, please contact YAMAHA sales office or dealer.

YAMAHA MOTOR CO., LTD.
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Chapter 1 About Safety

1-1 Safety Information

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks.

To ensure correct and safe use of YAMAHA industrial robots, carefully read this manual and make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS INCLUDED IN THIS MANUAL. Failure to take necessary safety measures or mishandling due to not following the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Warning information in this manual is shown classified into the following items.

DANGER

FAILURE TO FOLLOW DANGER INSTRUCTIONS WILL RESULT IN SEVERE INJURY OR DEATH TO THE ROBOT OPERATOR, BYSTANDERS OR PERSONS INSPECTING OR REPAIRING THE ROBOT.

WARNING

FAILURE TO FOLLOW WARNING INSTRUCTIONS COULD RESULT IN SEVERE INJURY OR DEATH TO THE ROBOT OPERATOR, BYSTANDERS OR PERSONS INSPECTING OR REPAIRING THE ROBOT.

CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, bystanders or persons inspecting or repairing the robot, or damage to the robot and/or robot controller.

NOTE

Explains the key point in the operation in a simple and clear manner.

It is not possible to list all safety items in detail within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation.

This manual and warning labels supplied with or affixed to the robot are written in English. If the robot operator or service personnel does not understand English, do not permit that person to handle the robot.

1-2 Essential Caution Items

Particularly important cautions for handling or operating the robot are described below. In addition, safety information about installation, operation, inspection and maintenance is provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

(1) Observe the following cautions during automatic operation.

- Install a safeguard (protective enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install safeguards so that no one can enter inside except from doors or panels equipped with safety interlocks.

DANGER
SERIOUS INJURY OR DEATH WILL RESULT FROM IMPACT WITH MOVING ROBOT.
· KEEP OUTSIDE OF GUARD DURING OPERATION.
· LOCK OUT POWER BEFORE APPROACHING ROBOT.

(2) Use caution to prevent hands or fingers from being pinched or crushed.

When moving the robot or performing teaching, use caution to prevent hand or fingers from being pinched or crushed by the robot movable parts.

WARNING
MOVING PARTS CAN PINCH OR CRUSH.
KEEP HANDS AWAY FROM ROBOT ARMS.

(3) Follow the instructions on listed in this manual.

- Before attempting installation and operation of the robot, be sure to read this manual carefully and follow the instructions.
- Before starting robot operation, be sure to reread the procedures and cautions relating to your work as well as descriptions in this chapter (Chapter 1, "About Safety").
- Never install, adjust, inspect or service the robot in any manner that does not comply with the instructions in this manual.

WARNING
IMPROPER INSTALLATION OR OPERATION CAN RESULT IN SERIOUS INJURY OR DEATH.
READ THIS MANUAL CAREFULLY BEFORE STATING INSTALLATION AND OPERATION.

(4) Do not use the robot in environments containing inflammable gas, etc.

WARNING
· THIS ROBOT WAS NOT DESIGNED FOR OPERATION IN ENVIRONMENTS WHERE INFLAMMABLE OR EXPLOSIVE SUBSTANCES ARE PRESENT.
· DO NOT USE THE ROBOT IN ENVIRONMENTS CONTAINING INFLAMMABLE GAS, DUST OR LIQUIDS.
EXPLOSIONS OR FIRE MIGHT OTHERWISE RESULT.

(5) Do not use the robot in locations possibly subject to electromagnetic interference, etc.

WARNING
AVOID USING THE ROBOT IN LOCATIONS SUBJECT TO ELECTROMAGNETIC INTERFERENCE, ELECTROSTATIC DISCHARGE OR RADIO FREQUENCY INTERFERENCE. MALFUNCTIONS MIGHT OTHERWISE OCCUR.

(6) Use caution when releasing the brake of a vertical use robot.

WARNING

THE VERTICAL AXIS WILL SLIDE DOWN WHEN THE BRAKE IS RELEASED, CAUSING A HAZARDOUS SITUATION.

- **PRESS THE EMERGENCY STOP BUTTON AND PROP UP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE RELEASING THE BRAKE.**
- **BE CAREFUL NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS AND INSTALLATION BASE WHEN RELEASING THE BRAKE TO PERFORM DIRECT TEACH.**

(7) Provide safety measures for end effector (gripper, etc.).

WARNING

- **END EFFECTORS MUST BE DESIGNED AND MANUFACTURED SO THAT THEY CREATE NO HAZARDS (FOR EXAMPLE, A WORKPIECE THAT COMES LOOSE) EVEN IF POWER (ELECTRICITY, AIR PRESSURE, ETC.) IS SHUT OFF OR POWER FLUCTUATIONS OCCUR.**
- **IF THERE IS A POSSIBLE DANGER THAT THE OBJECT GRIPPED BY THE END EFFECTOR MAY FLY OFF OR DROP, THEN PROVIDE APPROPRIATE SAFETY PROTECTION TAKING INTO ACCOUNT THE OBJECT SIZE, WEIGHT, TEMPERATURE AND CHEMICAL PROPERTIES.**

(8) Use caution when removing the motor. (Vertical use robots)

WARNING

THE VERTICAL AXIS WILL SLIDE DOWN WHEN THE MOTOR IS RELEASED, CAUSING A HAZARDOUS SITUATION.

- **TURN OFF THE ROBOT CONTROLLER AND PROP UP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE REMOVING THE MOTOR.**
- **BE CAREFUL NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS PARTS AND INSTALLATION BASE.**

(9) Take the following safety precautions during inspection of controller.

WARNING

- **WHEN YOU NEED TO TOUCH THE TERMINALS OR CONNECTORS ON THE OUTSIDE OF THE CONTROLLER DURING INSPECTION, ALWAYS FIRST TURN OFF THE CONTROLLER POWER SWITCH AND ALSO THE POWER SOURCE IN ORDER TO PREVENT POSSIBLE ELECTRICAL SHOCK.**
- **NEVER TOUCH ANY INTERNAL PARTS OF THE CONTROLLER.**
- **REFER TO THE "YAMAHA ROBOT CONTROLLER USER'S MANUAL" FOR PRECAUTIONS ON HANDLING THE CONTROLLER.**

(10) Consult us for corrective action when the robot is damaged or malfunctions occur.

WARNING

IF ANY PART OF THE ROBOT IS DAMAGED OR ANY MALFUNCTION OCCURS, CONTINUING THE OPERATION MAY BE VERY DANGEROUS. PLEASE CONSULT YOUR YAMAHA SALES OFFICE OR DEALER FOR CORRECTIVE ACTION.

Damage or Trouble	Possible Danger
Damage to machine harness or robot cable	Electrical shock, malfunction of robot
Damage to exterior of robot	Flying outwards of damaged parts during robot operation
Abnormal operation of robot (positioning error, excessive vibration, etc.)	Malfunction of robot
Z-axis brake trouble	Dropping of load

(11) Be careful not to touch the motor or speed reduction gear casing when hot.

WARNING

THE MOTOR AND SPEED REDUCTION GEAR CASING ARE EXTREMELY HOT AFTER AUTOMATIC OPERATION, SO BURNS MAY OCCUR IF THESE ARE TOUCHED.
BEFORE HANDLING THESE PARTS DURING INSPECTION OR SERVICING, TURN OFF THE CONTROLLER, WAIT FOR A WHILE AND CHECK THAT THE PART HAS COOLED.

(12) Do not remove, alter or stain the warning labels.

WARNING

IF WARNING LABELS ARE REMOVED OR DIFFICULT TO SEE, THEN ESSENTIAL PRECAUTIONS MIGHT NOT BE TAKEN, RESULTING IN ACCIDENTS.
- **DO NOT REMOVE, ALTER OR STAIN THE WARNING LABELS ON THE ROBOT.**
- **DO NOT ALLOW THE WARNING LABELS TO BE HIDDEN BY DEVICES INSTALLED ONTO THE ROBOT BY THE USER.**
- **PROVIDE PROPER LIGHTING SO THAT THE SYMBOLS AND INSTRUCTIONS ON THE WARNING LABELS CAN BE CLEARLY SEEN EVEN FROM OUTSIDE THE SAFETY ENCLOSURE**

(13) Protective bonding

WARNING

BE SURE TO GROUND THE ROBOT AND CONTROLLER TO PREVENT ELECTRICAL SHOCK.

(14) Be sure to make correct parameter settings.

CAUTION

The robot must be operated with the correct acceleration according to the tolerable moment of inertia and manipulator tip mass or moment of inertia. If this is not observed, drive unit service life may end prematurely, and damage to robot parts or residual vibration during positioning may result.

1-3 Special Training for Industrial Robot Operation

Companies or factories using industrial robots must make sure that every person, who handles the robot such as for teaching, programming, movement check, inspection, adjustment and repair, has received appropriate training and also has the skills needed to perform the job correctly and safely. Since the Pico series single-axis robots fall under the industrial robot category, the user must observe local regulations and safety standards for industrial robots, and provide special training for every person involved in robot-related tasks (teaching, programming, movement check, inspection, adjustment, repair, etc.).

1-4 Robot Safety Functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power.

(2) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation.
Note: The working envelope is the area limited by soft limits.

(3) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movement range.
No mechanical stopper is provided on the rotating axis.
Note: The movement range is the area limited by mechanical stoppers.

WARNING
AXIS MOVEMENT WILL NOT STOP IMMEDIATELY AFTER THE SERVO POWER SUPPLY IS SHUT OFF BY EMERGENCY STOP OR OTHER SAFETY FUNCTIONS.

(4) Vertical axis brake

An electromagnetic brake is installed on the vertical use robot to prevent the vertical axis from sliding down when servo power is turned off. This brake is working when the controller is off or the vertical axis servo power is off even when the controller is on.
The vertical axis brake can be released by means of the programming unit when the controller is on.

WARNING
THE VERTICAL AXIS WILL SLIDE DOWN WHEN THE BRAKE IS RELEASED, CREATING A HAZARDOUS SITUATION.
- **PRESS THE EMERGENCY STOP BUTTON AND PROP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE RELEASING THE BRAKE.**
- **USE CAUTION NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS AND INSTALLATION BASE WHEN RELEASING THE BRAKE TO PERFORM DIRECT TEACH.**

1-5 Safety Measures for the System

Since the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Accordingly, appropriate safety measures must be taken on the part of the system manufacturer according to the individual system. The system manufacturer should provide a proper instruction manual for safe, correct operation and servicing of the system.

1-6 Trial Operation

After making installations, adjustments, inspections, or maintenance or repairs to the robot, make a trial run using the following procedures.

(1) If a safety enclosure has not yet been provided right after installation of the robot, rope off or chain off around the movement area of the manipulator in place of the safeguard, and observe the following points.

1. Use sturdy, stable posts which will not fall over easily.
2. The rope or chain should be easily visible by everyone around the robot.
3. Place a sign to keep the operator or other personnel from entering the movement range of the manipulator.

(2) Check the following points before turning on the controller.

1. Is the robot securely and correctly installed?
2. Are the electrical connections to the robot correct?
3. Are items such as air pressure correctly supplied?
4. Is the robot correctly connected to peripheral equipment?
5. Have safety measures (safety enclosure, etc.) been taken?
6. Does the installation environment meet the specified standards.

(3) After the controller is turned on, check the following points from outside the safety enclosure.

1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
2. Does each axis move as intended within the soft limits?
3. Does the end effector move as intended?
4. Are the signal transmissions to the end effector and peripheral equipment correct?
5. Does emergency stop work?
6. Are the teaching and playback functions normal?
7. Are the safety enclosure and interlock working as intended?
8. Does the robot move correctly during automatic operation?

1-7 Work Within the Safety enclosure

(1) Work within the safety enclosure

When work is required inside the safety enclosure, always turn off the controller and place a sign indicating that the robot is being adjusted or serviced in order to keep any other person from touching the controller switch or operation panel, except for the following cases.

1) Soft limit settings (See Section 4 in Chapter 4.)

2) Teaching

For item 1), follow the precautions and procedure for each section. To perform item 2), refer to the description in (2) below.

(2) Teaching

When performing teaching within the safety enclosure, comply with the instructions listed below.

1) Check or perform the following points from outside the safety enclosure.

   1. Make sure that no hazards are present within the safety enclosure by a visual check.
   2. Check that the programming unit TP-2 operates correctly.
   3. Check that no failures are found in the robot.
   4. Check that emergency stop works correctly.
   5. Select teaching mode and prohibit automatic operation.

2) Never enter the movement range of the manipulator while within the safety enclosure.

1-8 Automatic Operation

(1) Checks before operation

Check the following points before starting automatic operation.

1. No one is within the safety enclosure.
2. The programming unit and tools are in their specified locations.
3. The alarm or error lamps on the robot and peripheral equipment do not flash.
4. The safety enclosure is securely installed with safety interlocks actuated.

(2) Precautions during operation or when an error occurs

1) After operation has started, check the operation status and signal light to ensure that the robot is in automatic operation.

2) Never enter the safety enclosure during operation.

3) If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safety enclosure.

   1. Press the emergency stop button to set the robot to emergency stop.
   2. Place a sign on the start switch, indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

1-9 Adjustment and Inspection

Do not attempt any installation, adjustment, inspection or maintenance unless it is described in this manual.

1-10 Repair and Modification

Do not attempt any repair, parts replacement and modification unless described in this manual. These works require technical knowledge and skill, and may also involve work hazards.

1-11 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description: If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:

(1)After 18 months (one and a half year) have elapsed from the date of shipment

(2)After one year has elapsed from the date of installation

(3)After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases:

(1)Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)

(2)Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).

(3)Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

1)Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.

2)Troubles caused by procedures prohibited in this manual.

3)Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.

4)Use of any other than genuine parts and specified grease and lubricants.

5)Incorrect or inadequate maintenance and inspection.

6)Repairs by other than authorized dealers.

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YAMAHA MOTOR CO., LTD. SOLE LIABILITY SHALL BE FOR THE DELIVERY OF THE EQUIPMENT AND YAMAHA MOTOR CO., LTD. SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES (WHETHER ARISING FROM CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY). YAMAHA MOTOR CO., LTD. MAKES NO WARRANTY WHATSOEVER WITH REGARD TO ACCESSORIES OR PARTS NOT SUPPLIED BY YAMAHA MOTOR CO., LTD.

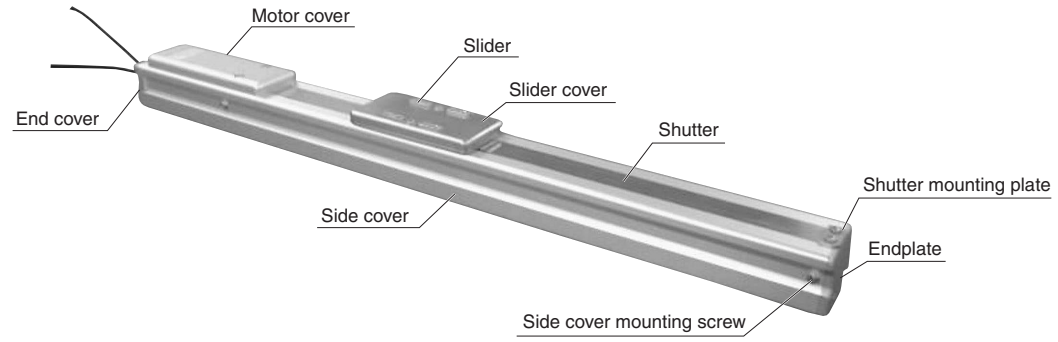
2-1 Checking the product

After unpacking, make sure that all components and accessories are included (as specified in your order). Also check the product for any damage on the exterior which might have occurred during transportation.

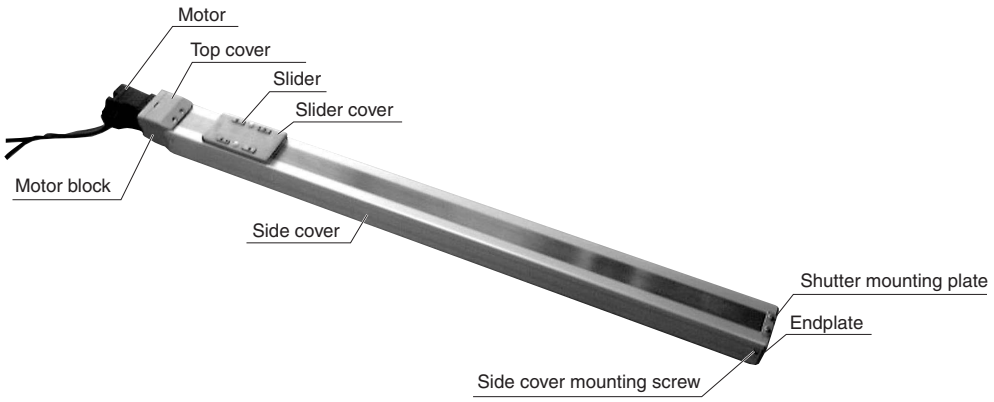
If there are any missing parts or damage due to transportation, please notify your YAMAHA sales office or dealer immediately.

2-2 Robot part names

T4P



T5P



2-3 Robot Installation Conditions

Be sure to install the robot in the following environments.

Items	Specifications
Allowable ambient temperature	0 to 45°C
Allowable ambient humidity	Below 90% RH (no condensation)
Altitude	0 to 1000 meters above sea level
Ambient environments	Avoid installing near water, cutting water, oil, dust, metallic chips and organic solvent.
	Avoid installation near corrosive gas and corrosive materials.
	Avoid installation in atmosphere containing inflammable gas, dust and liquid.
	Avoid installation near objects causing electromagnetic interference, electrostatic discharge and radio frequency interference.
Vibration	Do not subject to impacts or vibrations.
Working space	Allow sufficient space margin to perform jobs (teaching, inspection, repair, etc.)

For the controller installation conditions, refer to "PRC Single-axis Robot Controller User's Manual".

WARNING

AVOID INSTALLING THE ROBOT IN LOCATIONS WHERE THE AMBIENT CONDITIONS MAY EXCEED THE ALLOWABLE TEMPERATURE OR HUMIDITY, OR IN ENVIRONMENTS WHERE EXCESSIVE MOISTURE, CORROSIVE GASES, METALLIC POWDER OR DUST ARE GENERATED. MALFUNCTIONS, FAILURES OR SHORT CIRCUITS MAY OTHERWISE RESULT.

WARNING

- **THIS ROBOT WAS NOT DESIGNED FOR OPERATION IN ENVIRONMENTS WHERE INFLAMMABLE OR EXPLOSIVE SUBSTANCES ARE PRESENT.**
- **DO NOT USE THE ROBOT IN ENVIRONMENTS CONTAINING INFLAMMABLE GAS, DUST OR LIQUIDS. EXPLOSIONS OR FIRE COULD OTHERWISE RESULT.**

WARNING

AVOID USING THE ROBOT IN LOCATIONS SUBJECT TO ELECTROMAGNETIC INTERFERENCE, ELECTROSTATIC DISCHARGE OR RADIO FREQUENCY INTERFERENCE. MALFUNCTIONS MAY OTHERWISE OCCUR.

WARNING

DO NOT USE THE ROBOT IN LOCATIONS SUBJECT TO EXCESSIVE VIBRATION. ROBOT INSTALLATION BOLTS MAY OTHERWISE BECOME LOOSE CAUSING THE MANIPULATOR TO FALL OVER.

2-4 Installation base

To mount the robot, use an installation base that satisfies the following conditions.

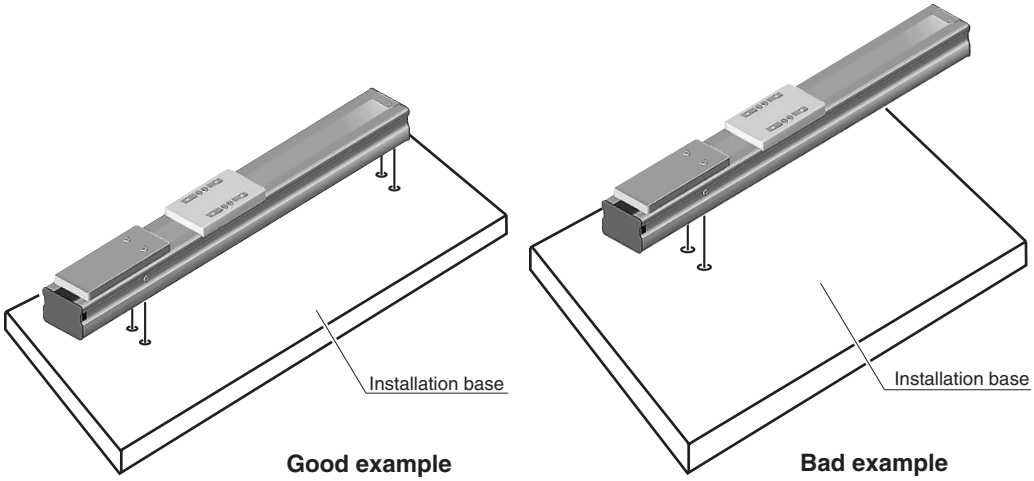
1) The installation base is subjected to a great deal of stress while the robot is in operation. Prepare a sufficiently rigid and stable installation base, taking into account the robot weight including the end effector (gripper) and workpiece.

CAUTION
If the installation base is not sufficiently rigid and stable, vibration (resonance) may occur during operation, causing adverse effects on the robot work.

2) The installation base surface must be machined within a flatness of ±0.05mm/500mm.

CAUTION
The robot positioning accuracy might decrease if the installation surface precision is insufficient.

3) Use an installation base of sufficient size to match the robot body so that the robot can be installed with the specified number of bolts. Avoid installing the robot with less than the specified number of bolts (4 bolts) or installing the robot closer to one end as shown at the lower right.

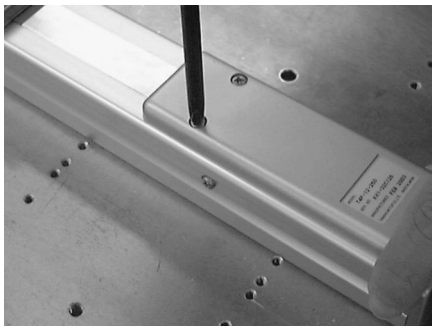
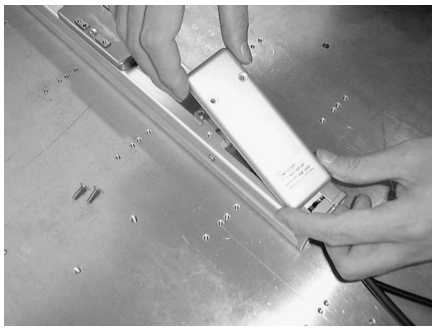


CAUTION
Using less than the specified number of bolts to install the robot may cause vibration and poor positioning accuracy.

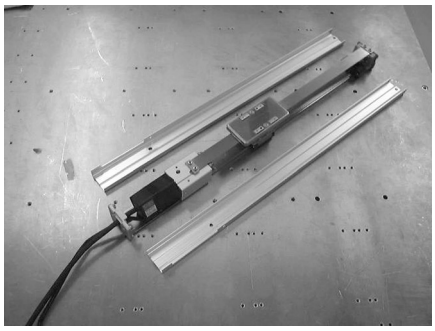
2-5 Installing the robot

2-5-1 T4P

1) Tap holes (M4 × 0.7, 4 or more locations) into the installation base where the robot is to be secured.
   For hole diameter and position, see the external view and dimensions in "4-1 Robot specifications" of this chapter4.)
2) Remove the screws securing the motor cover of the robot and remove the motor cover.

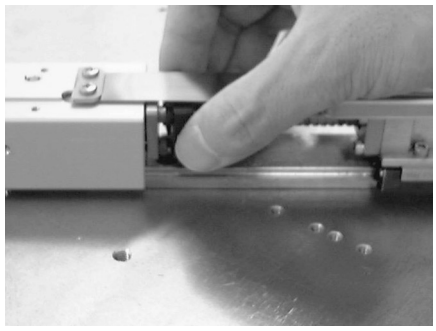



3) Remove the screws securing the side covers of the robot and remove the side covers on both sides.



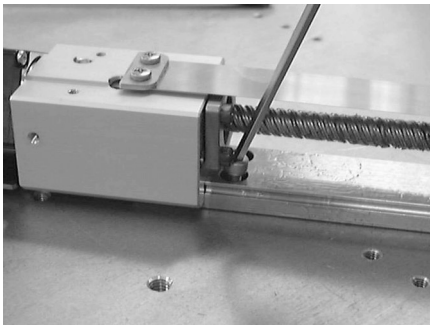
NOTE
If necessary, move the slider to a location where it does not hide the installation holes on the bottom of the robot frame.

4) Hold the mechanical stopper on the motor side between your fingers and pull it toward you to remove it.



5) Secure the robot to the base with the specified bolts (4 or more bolts) and torque.
The bolts and tightening torque are shown below.

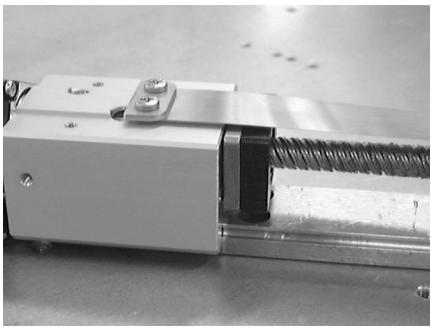
Robot Type	Bolt	Tightening torque
T4P	M4 (recommended length: 12mm)	3.0N·m to 4.5N·m



CAUTION
Be careful not to damage the shutter when tightening the bolts.

WARNING
BE SURE TO TIGHTEN THE BOLT TO THE CORRECT TORQUE. THE WRONG TORQUE MAY NOT ONLY CAUSE ROBOT POSITION ERRORS BUT ALSO LEAD TO SERIOUS ACCIDENTS.

6) Fit the motor side mechanical stopper into the head of the bolt and secure the stopper.
Fully insert the mechanical stopper so no gap exists between the plate and mechanical stopper.



7) Reattach the side covers and motor cover after installing the robot.
Be careful not to overtighten the motor cover mounting screws.
(Tightening torque should be less than 0.4N·m.)

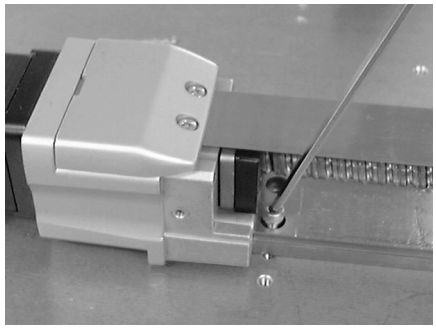
2-5-2 T5P

1) Tap holes (M4 × 0.7, 4 or more locations) into the installation base where the robot is to be secured.
   For hole diameter and position, see the external view and dimensions in "4-1 Robot specifications" of this chapter4.)
2) Remove the screws securing the side covers of the robot and remove the side covers on both sides.

NOTE
If necessary, move the slider to a location where it does not hide the installation holes on the bottom of the robot frame.

3) Secure the robot to the base with the specified bolts (4 or more bolts) and torque.
   The bolts and tightening torque are shown below.

Robot Type	Bolt	Tightening torque
T5P	M4 (recommended length: 15mm)	3.0N·m to 4.5N·m



CAUTION
Be careful not to damage the shutter when tightening the bolts.

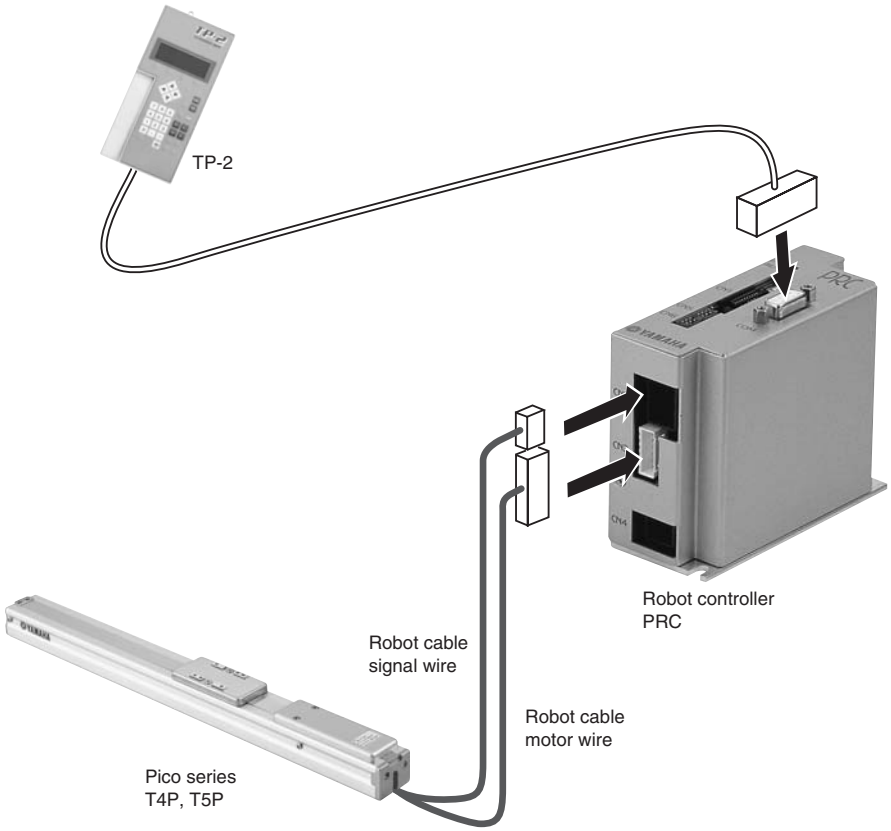
WARNING
BE SURE TO TIGHTEN THE BOLT TO THE CORRECT TORQUE. THE WRONG TORQUE MAY NOT ONLY CAUSE ROBOT POSITION ERRORS BUT ALSO LEAD TO SERIOUS ACCIDENTS.

4) Reattach the side covers after installing the robot.

2-6 Connections

2-6-1 Connecting the robot cables

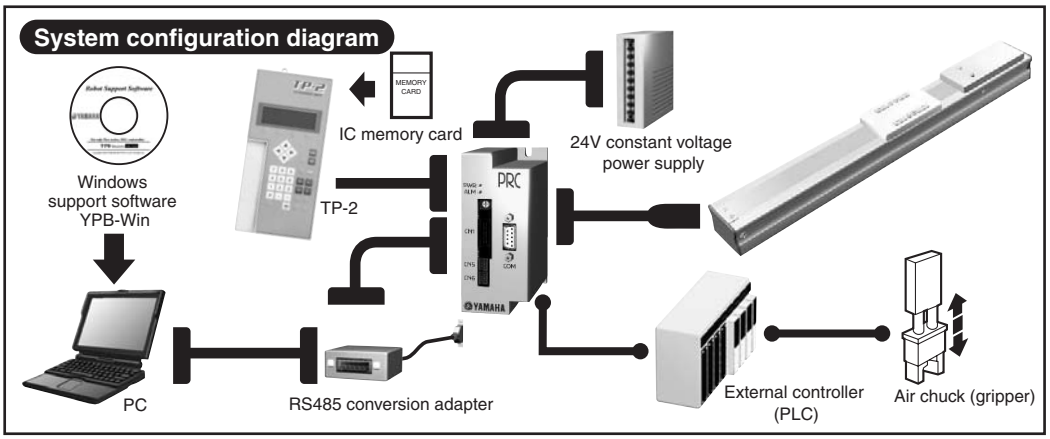
Connect the robot cables to the mating connectors on the controller as shown below. Refer to the PRC single-axis robot controller user's manual for the controller connectors.



WARNING

BEFORE CONNECTING THE CABLES, CHECK THAT THERE ARE NO BENDS OR BREAKS IN THE ROBOT CABLE CONNECTOR PINS AND THAT THE CABLES ARE NOT DAMAGED. BENT OR BROKEN PINS OR CABLE DAMAGE MAY CAUSE ROBOT MALFUNCTIONS.

2-6-2 System Configuration Example



MEMO

Chapter 3 Periodic Inspection

3-1 Before beginning work

Periodic inspection and maintenance are essential to ensure safe and efficient operation of YAMAHA robots. This chapter describes periodic inspection items and procedures for the YAMAHA Pico series robots. Before beginning work, read the precautions below and also in Chapter 1, "About Safety", and always follow the instructions.

DANGER

IF THE INSPECTION OR MAINTENANCE PROCEDURE CALLS FOR OPERATION OF THE ROBOT, STAY OUT OF THE WORKING AREA OF THE ROBOT DURING OPERATION. DO NOT TOUCH ANY PARTS INSIDE THE CONTROLLER.
KEEP WATCHING THE ROBOT MOVEMENT AND SURROUNDING AREA SO THAT THE OPERATOR CAN PRESS THE EMERGENCY STOP BUTTON IF ANY DANGER OCCURS.

WARNING

- **WHEN THE ROBOT DOES NOT NEED TO BE OPERATED DURING ADJUSTMENT OR MAINTENANCE, ALWAYS TURN OFF THE CONTROLLER AND THE EXTERNAL SWITCH BOARD.**
- **DO NOT TOUCH INTERNAL PARTS OF THE CONTROLLER FOR 5 SECONDS AFTER THE CONTROLLER HAS BEEN TURNED OFF.**
- **PUT THE ROBOT IN EMERGENCY STOP WHEN PERFORMING ELECTRICAL INSPECTION NOT REQUIRING ROBOT MOVEMENT.**
- **USE ONLY LUBRICANT AND GREASES SPECIFIED BY YAMAHA SALES OFFICE OR DEALER.**
- **USE ONLY PARTS SPECIFIED BY YAMAHA SALES OFFICE OR DEALER. TAKE SUFFICIENT CARE NOT TO ALLOW ANY FOREIGN MATTER TO CONTAMINATE THEM DURING ADJUSTMENT, PARTS REPLACEMENT OR REASSEMBLY.**
- **DO NOT MODIFY ANY PARTS ON THE ROBOT OR CONTROLLER. MODIFICATION MAY RESULT IN UNSATISFACTORY SPECIFICATIONS OR THREATEN OPERATOR SAFETY.**
- **WHEN ADJUSTMENT OR MAINTENANCE IS COMPLETE, RETIGHTEN THE BOLTS AND SCREWS SECURELY.**
- **DURING ROBOT ADJUSTMENT OR MAINTENANCE, PLACE A SIGN INDICATING THAT THE ROBOT IS BEING ADJUSTED OR SERVICED, TO PREVENT OTHERS FROM TOUCHING THE CONTROL KEYS OR SWITCHES. PROVIDE A LOCK ON THE SWITCH KEYS OR ASK SOMEONE TO KEEP WATCH AS NEEDED.**

When applying grease to the ball screws and linear guide, take the following precautions.

WARNING

PRECAUTIONS WHEN HANDLING GREASE:

- **INFLAMMATION MAY OCCUR IF THIS GETS IN THE EYES. BEFORE HANDLING THE GREASE, WEAR YOUR SAFETY GOGGLES TO ENSURE THE GREASE WILL NOT COME IN CONTACT WITH THE EYES.**
- **INFLAMMATION MAY OCCUR IF THE GREASE COMES INTO CONTACT WITH SKIN. BE SURE TO WEAR PROTECTIVE GLOVES TO PREVENT CONTACT WITH SKIN.**
- **DO NOT TAKE ORALLY OR EAT. (EATING WILL CAUSE DIARRHEA AND VOMITING.)**
- **HANDS AND FINGERS MIGHT BE CUT WHEN OPENING THE CONTAINER, SO USE PROTECTIVE GLOVES.**
- **KEEP OUT OF THE REACH OF CHILDREN.**
- **DO NOT HEAT THE GREASE OR PLACE NEAR AN OPEN FLAME SINCE THIS COULD LEAD TO SPARKS AND FIRES.**

EMERGENCY TREATMENT:

- **IF GREASE GETS IN THE EYES, WASH LIBERALLY WITH PURE WATER FOR ABOUT 15 MINUTES AND CONSULT A PHYSICIAN FOR TREATMENT.**
- **IF GREASE COMES IN CONTACT WITH THE SKIN, WASH AWAY COMPLETELY WITH SOAP AND WATER.**
- **IF TAKEN INTERNALLY, DO NOT INDUCE VOMITING BUT PROMPTLY CONSULT A PHYSICIAN FOR PROPER TREATMENT.**

3-2 Periodic inspection

3-2-1 Daily inspection

Check the following points on a daily basis, before and after robot operation.

Checkpoints	Check items	Notes
Cables and shutter	Check for scratches, dents, and excessively tight bends.	Replace if necessary.
Ball screws and bearings	Check for unusual vibration and noise.	See "3-4" in this chapter.
Motor	Check for unusual vibration and noise, and for abnormal temperature rise.	

3-2-2 Three-month inspection

Check the following points every 3 months and apply grease if needed.

Checkpoints	Check items	Notes
Ball screw, linear guide and ball bushing	Check for dirt or grime. If dirt or grime is found, clean the part. Apply grease after cleaning. Apply grease if the items checked are dry or do not have enough grease. Recommended grease is as follows: Standard model : Use Alvania No. (Showa Shell), Daphne Eponex No.2 (Idemitsu) Clean room model : Use LG-2 (NSK)	See "3-3" in this chapter.
Shutter	Check for slack. Adjust if necessary.	See "3-5" in this chapter.
Coupling	Check if the bolts are loose. Tighten if necessary.	See "3-7" in this chapter.

CAUTION

Using a grease other than recommended by YAMAHA may shorten the service life of the ball screw, linear guide and linear bushing shaft.

3-2-3 Six-month inspection

Check the following points every six months, and make adjustments or apply grease if necessary.

Checkpoints	Check items	Notes
Main bolts and screws on robot	Check for looseness. If loose, tighten.	
Ball screw and linear guide	Check for looseness in the ball screw and linear guide. Tighten if necessary. Check for vibration during operation. Tighten drive section, and X and Y axis installation bolts if necessary. Check for wear and backlash. If any abnormality is found, contact YAMAHA sales office or dealer.	If problem is not solved or wear and backlash are found, please contact us.
Controller	Check for loose terminals. Check for loose connectors.	
Lubrication of ball screw nut and linear guides	Apply Alvania No.2 (Showa Shell), Daphne Eponex No.2 (Idemitsu Sekiyu) to the ball screw nut and linear guides.	See "3-3" in this chapter
Coupling	Check if the bolts are loose. Tighten if necessary.	See "3-7" in this chapter

CAUTION

Using a grease other than recommended by YAMAHA may shorten the service life of the ball screw, linear guide and linear bushing shaft.

3-2-4 Three-year inspection

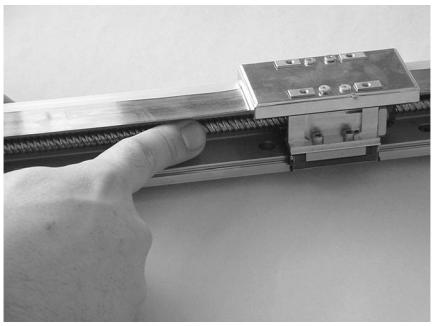
Inspect the following points once every three years, and contact us if any problem is found. Set an earlier inspection interval if parts are subject to long-term or frequent usage.

Checkpoints	Check items	Notes
Ball screw nut sections and linear guides	Check for wear and looseness in the ball screw, nut and linear guide.	Contact us if trouble is found.

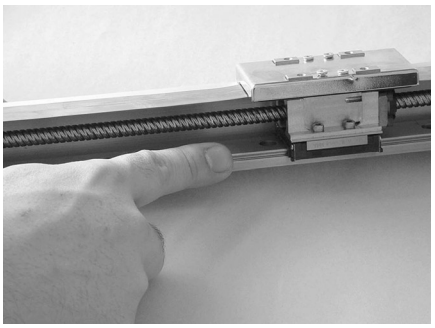
3-3 Applying grease

Follow these steps when applying grease to the robot ball screws and linear guides according to periodic maintenance.

1) Remove the screw securing the robot side covers and remove the side covers.
2) Coat the ball screw and linear guides with grease by hand and move the slider back and forth to spread the grease.



Applying grease to the ball screw



Applying grease to the linear guide

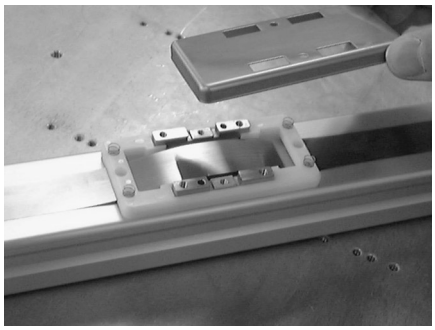
3) Reattach the side covers.

3-4 Replacing the shutter

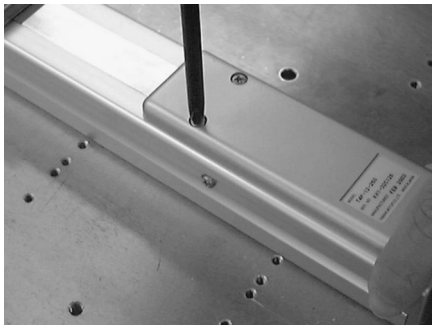
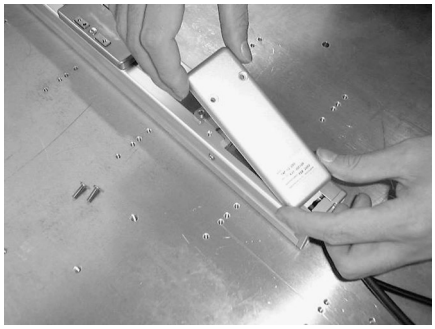
Use the following procedure when the shutter must be replaced. Make sure that the controller power switch is off before beginning work.

3-4-1 T4P

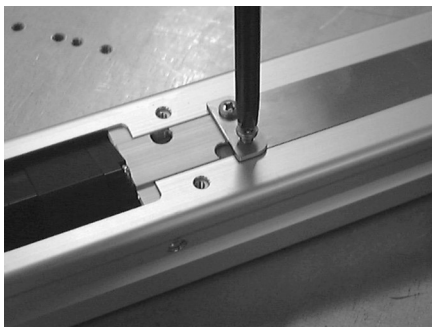
1) Remove the 4 screws securing the slider cover and take off the slider cover.



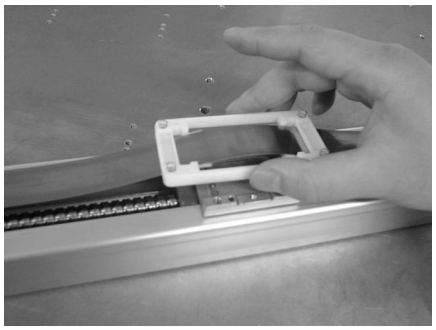
2) Remove the screws securing the motor cover of the robot and remove the motor cover.

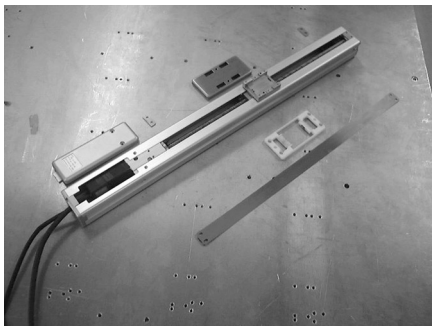



3) Remove the screws securing the shutter.
Remove the 2 screws on the endplate side and the 2 screws on the motor side.



4) Remove the shutter and shutter guide from the robot.
Remove the shutter from the shutter guide and pass the new shutter through it.



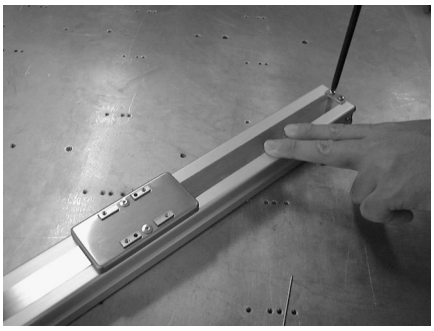


5) Reinstall the shutter, motor cover and slider cover using the reverse procedure.
Be careful not to overtighten the motor cover mounting screws.
(Tightening torque should be less than 0.4N·m.)

NOTE

Do not fully tighten the screws to secure the shutter on the endplate side at this time. Fully tighten these screws after adjusting for shutter looseness in step 6.

6) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.

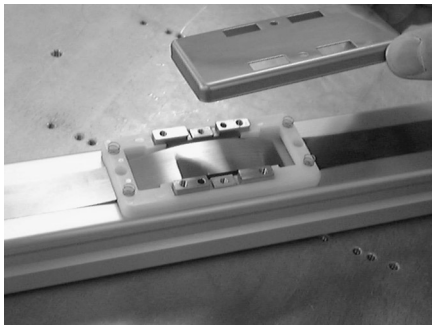


CAUTION

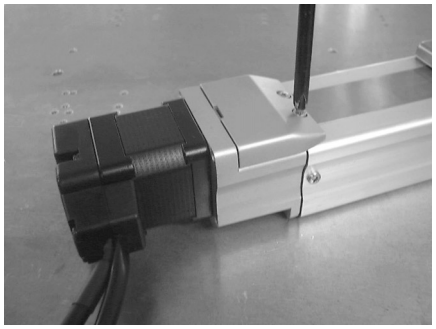
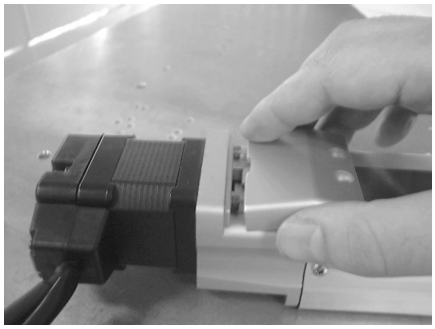
Do not press down on the shutter with excessive force.
Pressing down hard on the shutter may cause the shutter to warp.

3-4-2 T5P

1) Remove the 4 screws securing the slider cover and take off the slider cover.

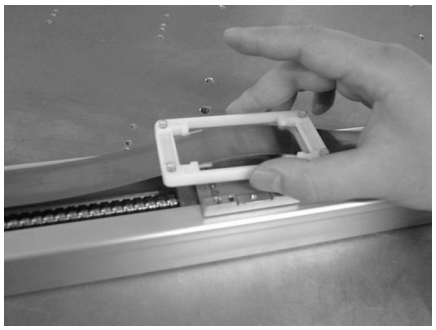


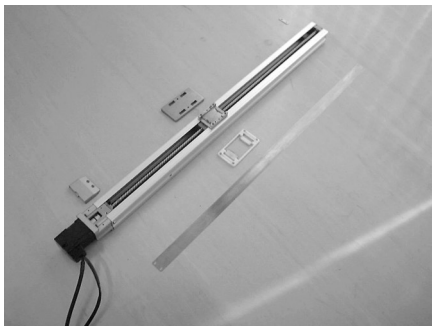
2) Remove the screws securing the top cover and remove the top cover.

3) Remove the two screws securing the shutter on the end block side.

4) Remove the shutter and shutter guide from the robot.
Remove the shutter from the shutter guide and pass the new shutter through it.



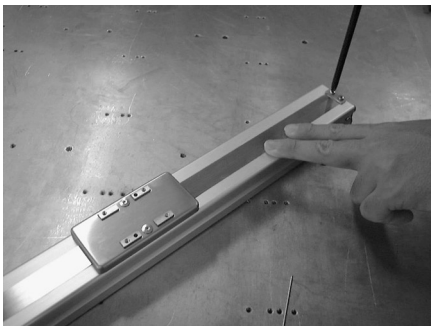


5) Reinstall the shutter, top cover and slider cover using the reverse procedure.
Be careful not to overtighten the top cover mounting screws.
(Tightening torque should be less than 0.4N·m.)

NOTE

Do not fully tighten the screws to secure the shutter on the endplate side at this time. Fully tighten these screws after adjusting for shutter looseness in step 6.

6) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.



CAUTION

Do not press down on the shutter with excessive force.
Pressing down hard on the shutter may cause the shutter to warp.

3-5 Adjusting shutter looseness

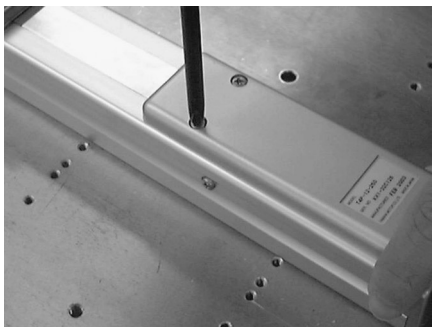
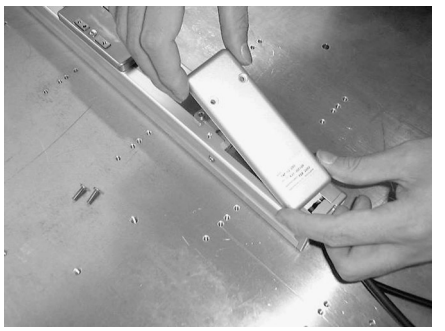
The shutter may elongate with continued use. In such cases, adjust as follows.

1) Slightly loosen the two screws securing the endplate side of the shutter. (Do not remove.)
2) While pulling on the shutter with your fingers, tighten the screws so that there is no looseness. See step 6 of "3-4 Replacing the shutter".

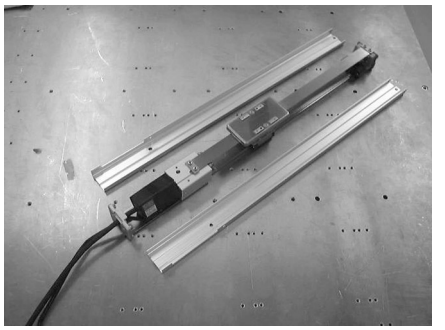
3-6 Replacing the motor

3-6-1 T4P

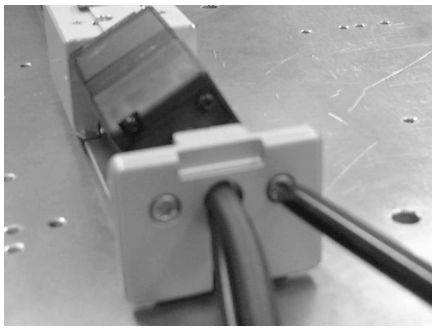
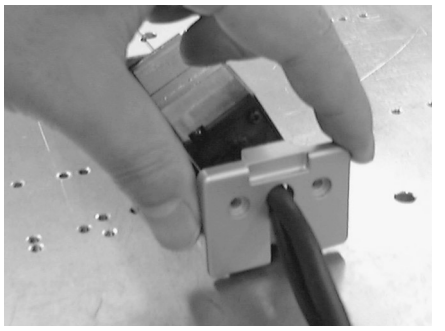
1) Remove the screws securing the motor cover and remove the motor cover.

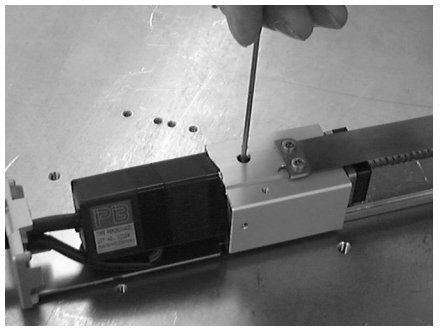
2) Remove the screws securing the side covers of the robot and remove the side covers on both sides.



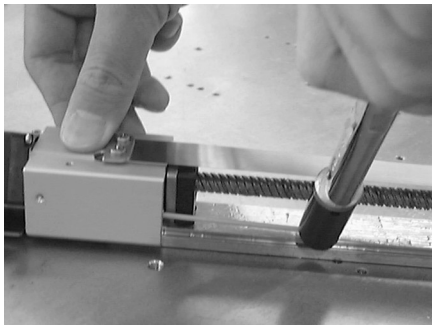
3) Remove the screws securing the end cover and remove the end cover.

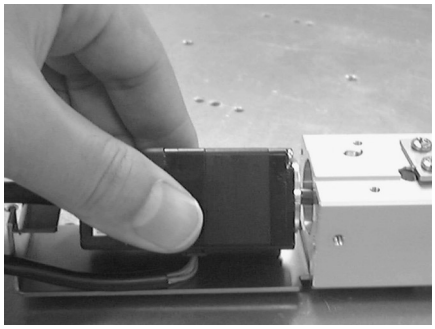



4) Loosen the bolt (M2.6, one piece) securing the coupling on the motor side.

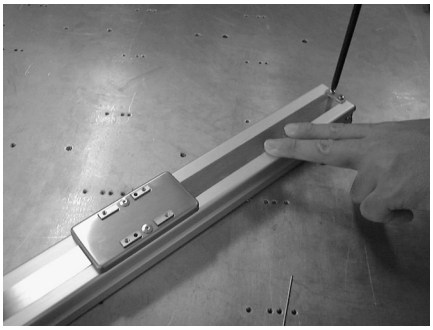


5) Remove the bolts (M2.6, 2 pieces) securing the motor and remove the motor.





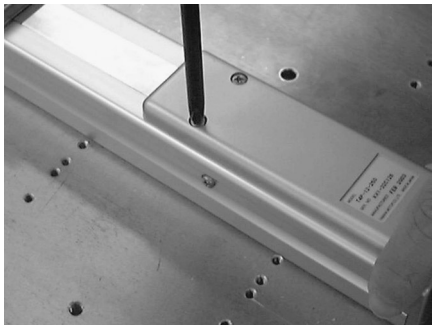
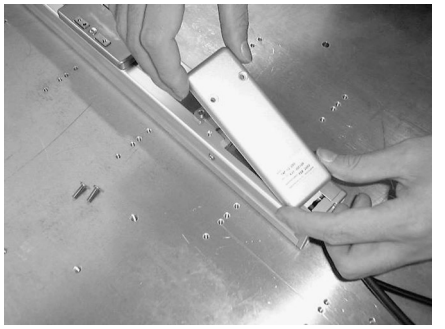
6) Attach a new motor and tighten the bolts to secure the new motor. (Tightening torque: 1.0N·m.)
7) Tighten the bolt to secure the coupling on the motor side. (Tightening torque: 1.0N·m.)
8) Reattach the end cover, side covers and motor cover using the reverse procedure.
Do not overtighten the end cover and motor cover mounting screws.
(Tightening torque should be less than 0.4N·m.)
9) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.



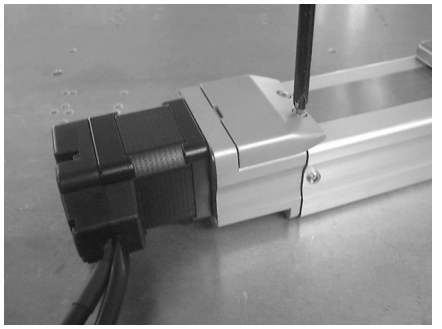
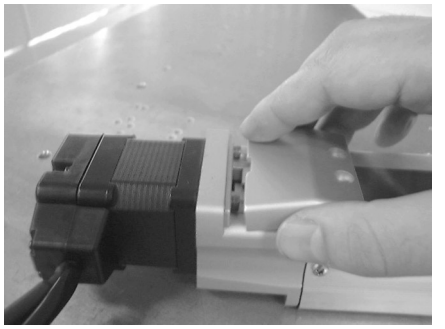
CAUTION
Do not press down on the shutter with excessive force.
Pressing down hard on the shutter may cause the shutter to warp.

3-6-2 T5P

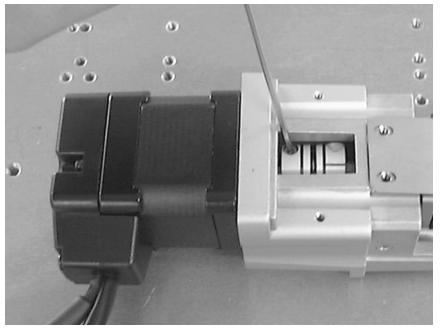
1) Remove the screws securing the motor cover and remove the motor cover.

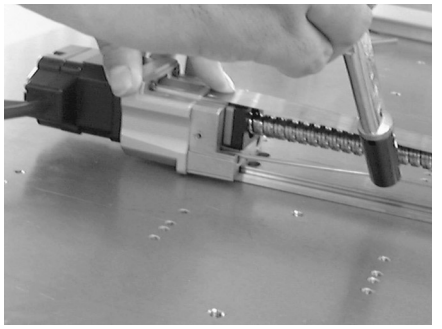
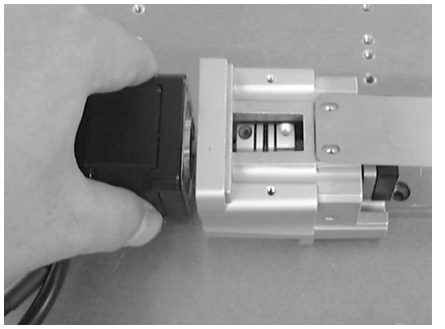
2) Remove the screws securing the top cover and remove the top cover.

3) Loosen the bolt (M2.6, one piece) securing the coupling on the motor side.



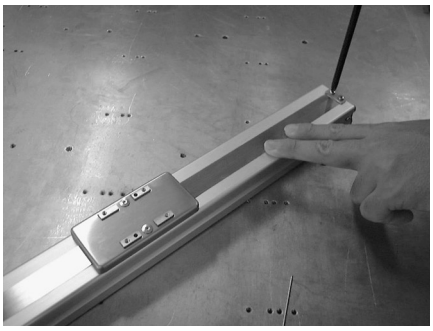
4) Remove the bolts (M3, 4 pieces) securing the motor and remove the motor.

5) Attach a new motor and tighten the bolts to secure the new motor. (Tightening torque: 2.0N·m.)
6) Tighten the bolt to secure the coupling on the motor side. (Tightening torque: 1.0N·m.)

7) Reattach the side covers and top cover using the reverse procedure.
Be careful not to overtighten the top cover mounting screws.
(Tightening torque should be less than 0.4N·m.)

8) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.



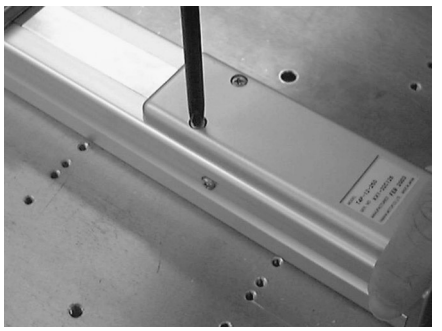
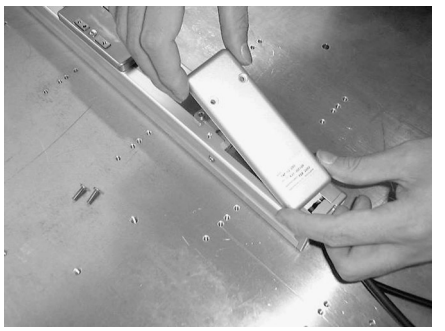
CAUTION

Do not press down on the shutter with excessive force.
Pressing down hard on the shutter may cause the shutter to warp.

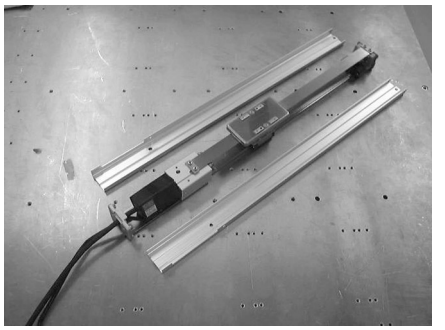
3-7 Replacing the coupling

3-7-1 T4P

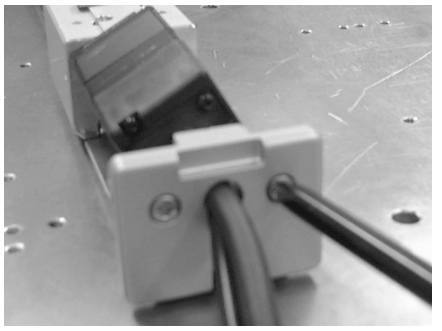
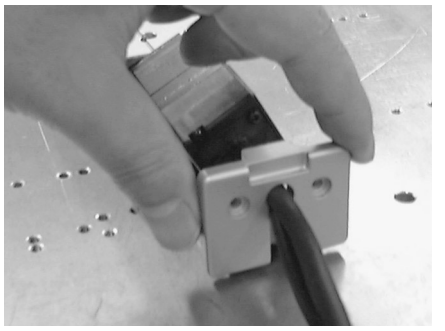
1) Remove the screws securing the motor cover and remove the motor cover.

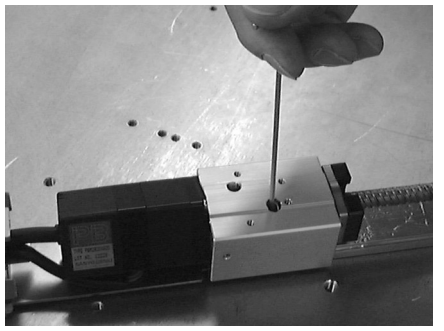
2) Remove the screws securing the side covers of the robot and remove the side covers on both sides.



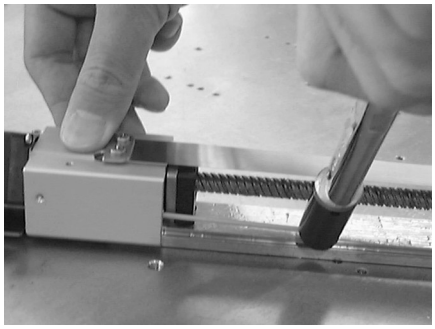
3) Remove the screws securing the end cover and remove the end cover.

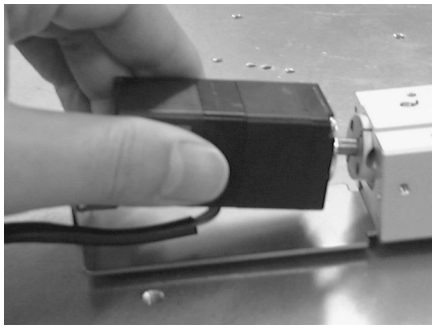



4) Loosen the bolt (M2.6, one piece) securing the coupling on the ball screw side.

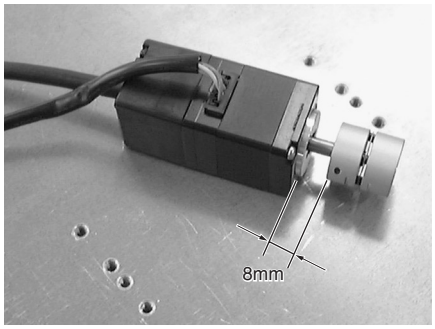


5) Remove the bolts (M2.6, 2 pieces) securing the motor and remove the motor.





6) Loosen the bolt (M2.6, one piece) securing the coupling and remove the coupling from the motor. Then attach a new coupling to the motor. (Tightening torque: 1.0N·m.)

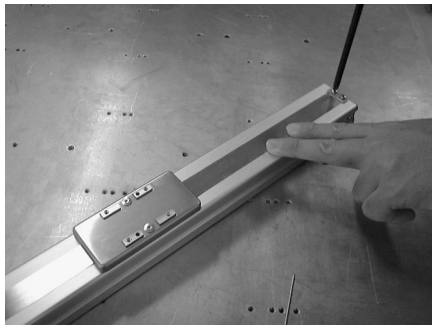


7) Attach the motor and secure it by tightening the bolts. (Tightening torque: 1.0N·m.)

8) Loosen the bolt securing the coupling on the ball screw side. (Tightening torque: 1.0N·m.)

9) Reattach the end cover, side covers and motor cover using the reverse procedure.
Do not overtighten the end cover and motor cover mounting screws.
(Tightening torque should be less than 0.4N·m.)

10) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.

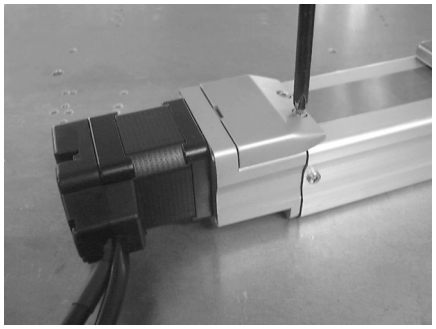
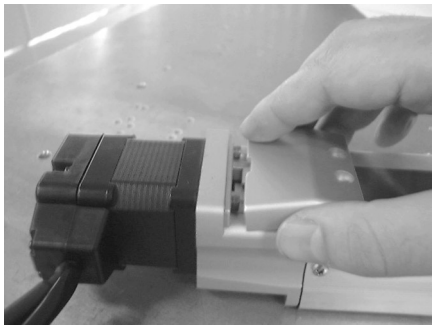


CAUTION

Do not press down on the shutter with excessive force.
Pressing down hard on the shutter may cause the shutter to warp.

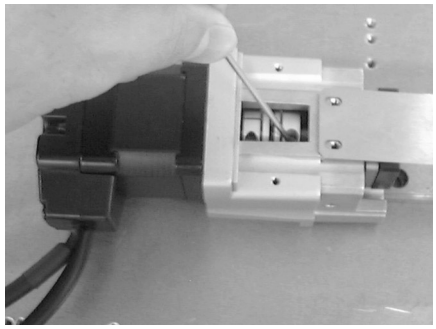
3-7-2 T5P

1) Remove the screws securing the top cover and remove the top cover.

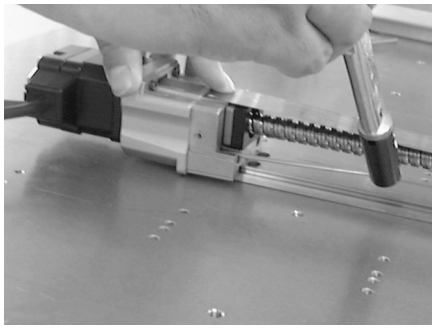
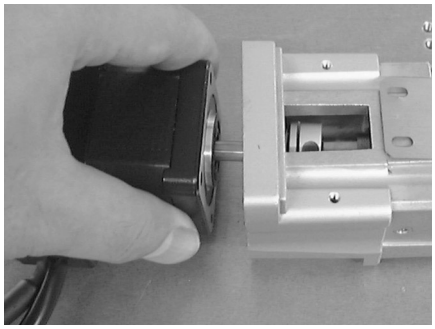



2) Remove the screws securing the side covers of the robot and remove the side covers on both sides.

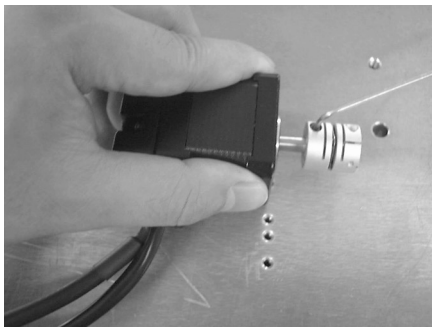
3) Loosen the bolt (M2.6, one piece) securing the coupling on the ball screw side.

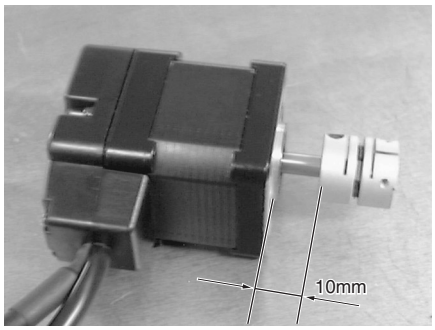


4) Remove the bolts (M3, 4 pieces) securing the motor and remove the motor.

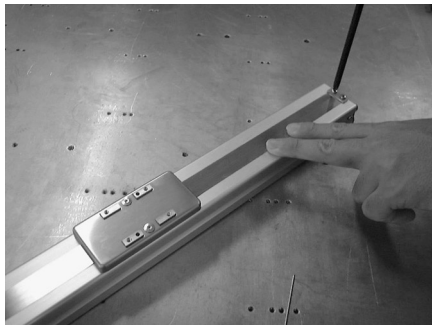



5) Loosen the bolt (M2.6, one piece) securing the coupling and remove the coupling from the motor. Then attach a new coupling to the motor. (Tightening torque: 1.0N·m.)





6) Attach the motor and secure it by tightening the bolts. (Tightening torque: 2.0N·m.)
7) Loosen the bolt securing the coupling on the ball screw side. (Tightening torque: 1.0N·m.)
8) Reattach the side covers and top cover using the reverse procedure.
Be careful not to overtighten the top cover mounting screws.
(Tightening torque should be less than 0.4N·m.)
9) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.



CAUTION
Do not press down on the shutter with excessive force.
Pressing down hard on the shutter may cause the shutter to warp.

MEMO

4-1 Robot specifications

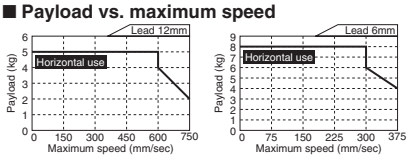
4-1-1 T4P

■ Basic specifications

Robot model		T4P	
Repetitive positioning accuracy (mm)*1		±0.02	
Reduction mechanism		Ball screw	
Ball screw lead (mm)		12	6
Maximum speed (mm/sec)*2		750	375
Maximum payload (kg)	Horizontal use	5	8
	Vertical use	-	-
Stroke (mm)		50 to 300 (50mm pitch steps)	
Cable length (m)		3.5 (standard cable), 5 or 10	
Controller		PRC 1	

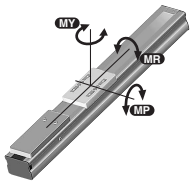
*1: Positioning repeatability in one direction
*2: See payload vs. maximum speed graphs below.

■ Payload vs. maximum speed

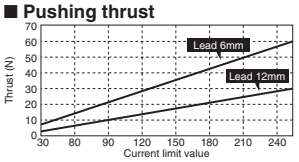


■ Static allowable load moment (N · m)

MY	MP	MR
6.2	5.7	15.9



■ Pushing thrust

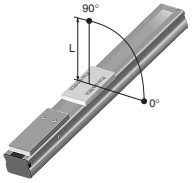


* Reference value: The above data does not guarantee the thrust power accuracy maintained when the robot is stopped. Use this data for reference only.

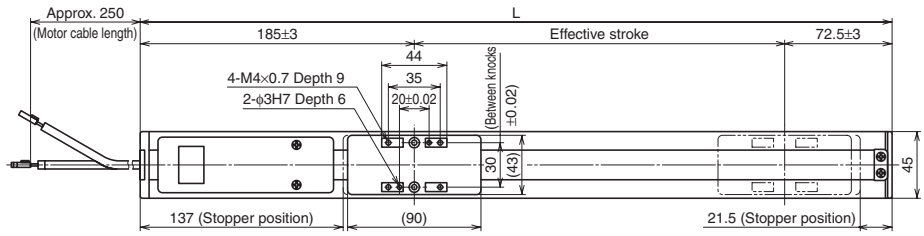
■ Dynamic allowable load moment (mm)

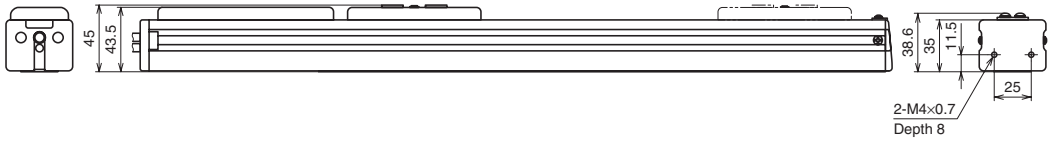
			0°	90°
Horizontal use	Lead 12	2kg	192	344
		5kg	87	188
	Lead 6	4kg	151	340
		8kg	87	301

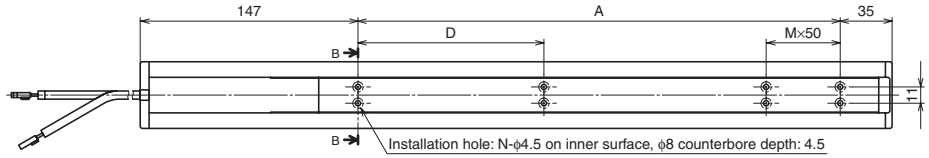
Horizontal use



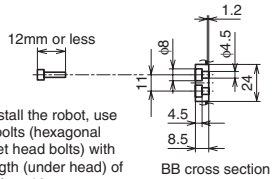
■ T4P Demensions Robot







Effective stroke	50	100	150	200	250	300
L	307.5	357.5	407.5	457.5	507.5	557.5
A	125.5	175.5	225.5	275.5	325.5	375.5
D	-	-	-	-	125.5	125.5
M	0	1	2	3	0	1
N	4	6	8	10	6	8
Weight (kg)	1.2	1.3	1.4	1.5	1.6	1.7



* To install the robot, use hex bolts (hexagonal socket head bolts) with a length (under head) of less than 12mm.

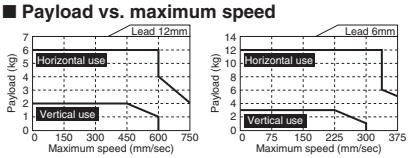
4-1-2 T5P

■ Basic specifications

Robot model		T5P	
Repetitive positioning accuracy (mm)*1		±0.02	
Reduction mechanism		Ball screw	
Ball screw lead (mm)		12	6
Maximum speed	Horizontal use	750	375
(mm/sec)*2	Vertical use	600	300
Maximum	Horizontal use	6	12
payload (kg)	Vertical use	1.5	3
Stroke (mm)		50 to 600 (50mm pitch steps)	
Cable length (m)		3.5 (standard cable), 5 or 10	
Controller		PRC 2	

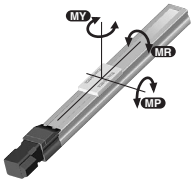
*1: Positioning repeatability in one direction
*2: See payload vs. maximum speed graphs below.

■ Payload vs. maximum speed

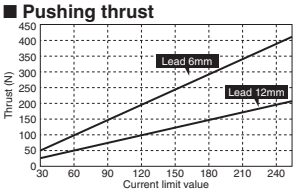


■ Static allowable load moment (N · m)

MY	MP	MR
10.9	10.0	29.4



■ Pushing thrust

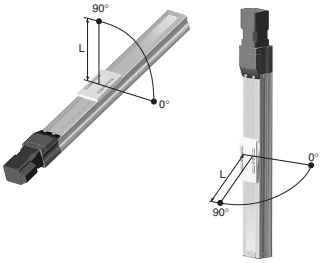


* Reference value: The above data does not guarantee the thrust power accuracy maintained when the robot is stopped. Use this data for reference only.

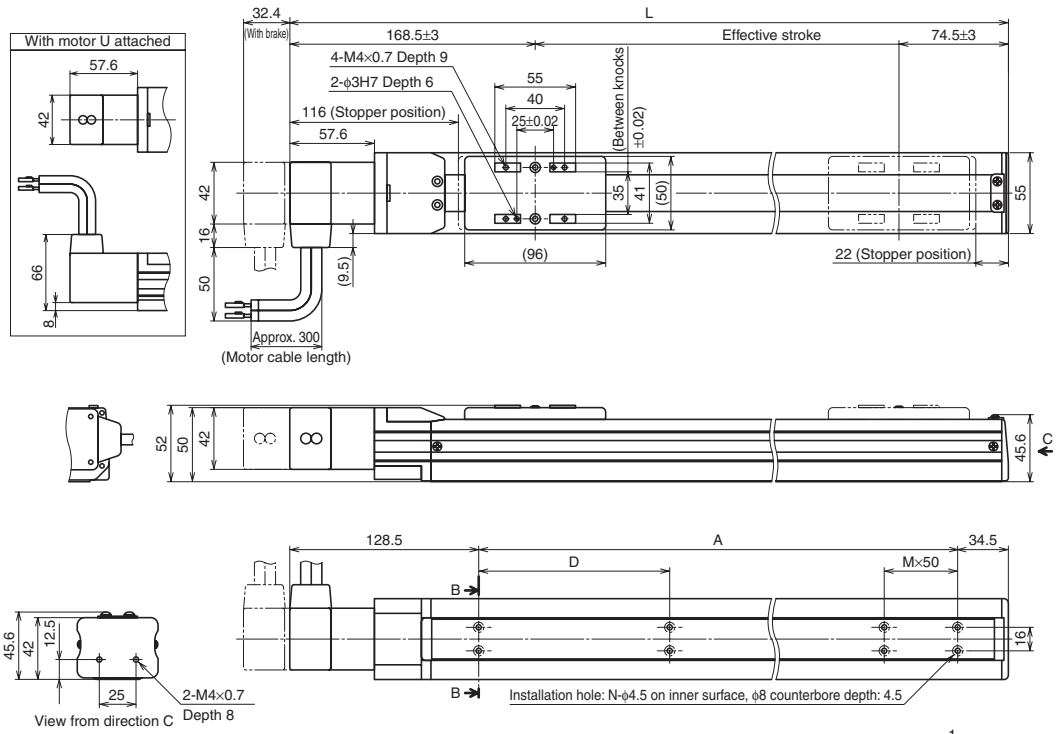
■ Dynamic allowable load moment (mm)

			0°	90°
Horizontal use	Lead 12	3kg	270	521
		6kg	151	363
	Lead 6	6kg	211	846
		12kg	111	415
Vertical use	Lead 12	1.5kg	209	249
	Lead 6	3kg	125	150

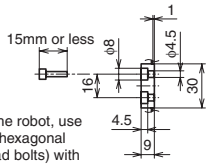
Horizontal use **Vertical use**



■ T5P Demensions Robot



Effective stroke	50	100	150	200	250	300	350	400	450	500	550	600
L	293	343	393	443	493	543	593	643	693	743	793	843
A	130	180	230	280	330	380	430	480	530	580	630	680
D	-	-	-	-	-	-	230	230	230	230	230	230
M	0	1	2	3	4	5	0	1	2	3	4	5
N	4	6	8	10	12	14	6	8	10	12	14	16
Weight (kg)	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3



* To install the robot, use hex bolts (hexagonal socket head bolts) with a length (under head) of less than 15mm.

4-2 Servo motor specifications

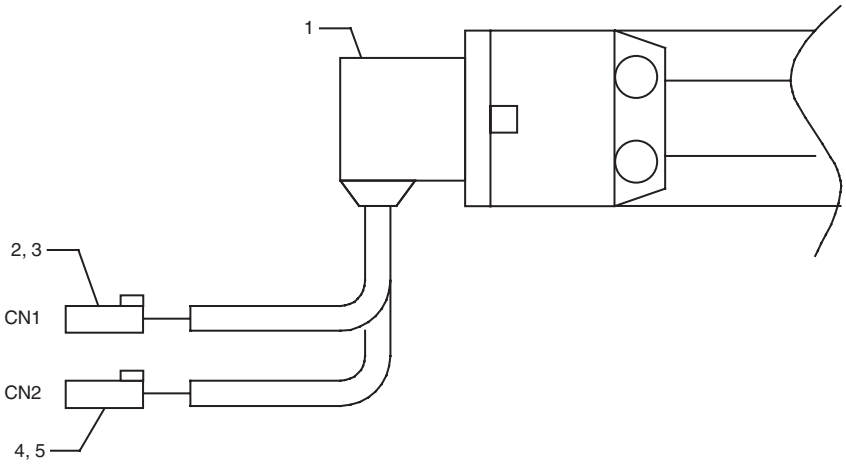
4-2-1 Servo motor termination

■ Connector specifications

No.	Parts	Type No.	Maker	Qty	Note
1	Servo motor			1	
2	Housing	51030-0930	Japan MOLEX	1	CN1
3	Contact	50084-8060	Japan MOLEX	7	
4	Housing	51111-0610	Japan MOLEX	1	CN2
5	Contact	50397-8100	Japan MOLEX	4(6)	value in ( ) for model with brake

■ Connector wiring

Connector	Pin No.	Signal name	Wire Color	Note
CN1	1	A	Blue	
	2	$\overline{A}$	Brown	
	3	B	Orange	
	4	$\overline{B}$	Purple	
	5	NC	-	Not used
	6	NC	-	Not used
	7	+5V	Red	
	8	5GND	Black	
	9	FG	Black	Shield
CN2	1	A	Blue	
	2	$\overline{A}$	Orange	
	3	B	Red	
	4	$\overline{B}$	Yellow	
	5	BRK+	Brown	Only for model with brake
	6	BRK-	White	Only for model with brake

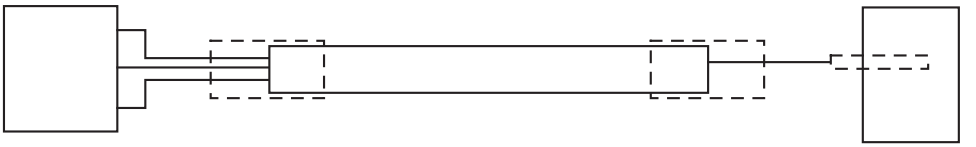


4-3 Robot cable

■ Signal wires

Controller side

Motor side

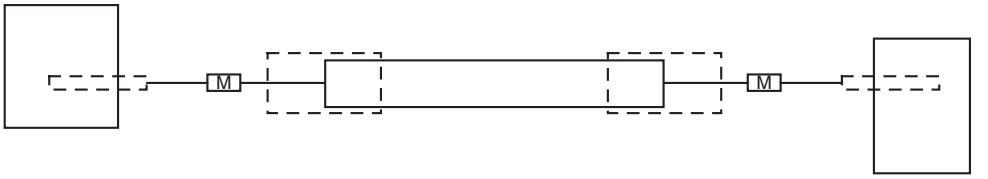


Parts	Signal	PIN	Connection	PIN	Signal	Parts	Wire
Controller CN2	A	1		1	A	Encoder	0.3sq Blue
	$\overline{A}$	2		2	$\overline{A}$		Orange
	B	3		3	B		Yellow
	$\overline{B}$	4		4	$\overline{B}$		Black
	+5V	7		7	+5V		Red
	5GND	8		8	5GND		Gray
	F, G	9		9	F, G		

■ Power wires

Controller side

Motor side



Parts	Signal	PIN	Connection	PIN	Signal	Parts	Wire
Controller CN3	A	1		1	A	Motor	0.3sq Blue
	$\overline{A}$	2		2	$\overline{A}$		Orange
	B	3		3	B		Yellow
	$\overline{B}$	4		4	$\overline{B}$		Black
	BRK+	5		5	BRK+		Red
	BRK-	6		6	BRK-		Gray

4-4 Robot usage conditions

4-4-1 Parameter settings according to payload

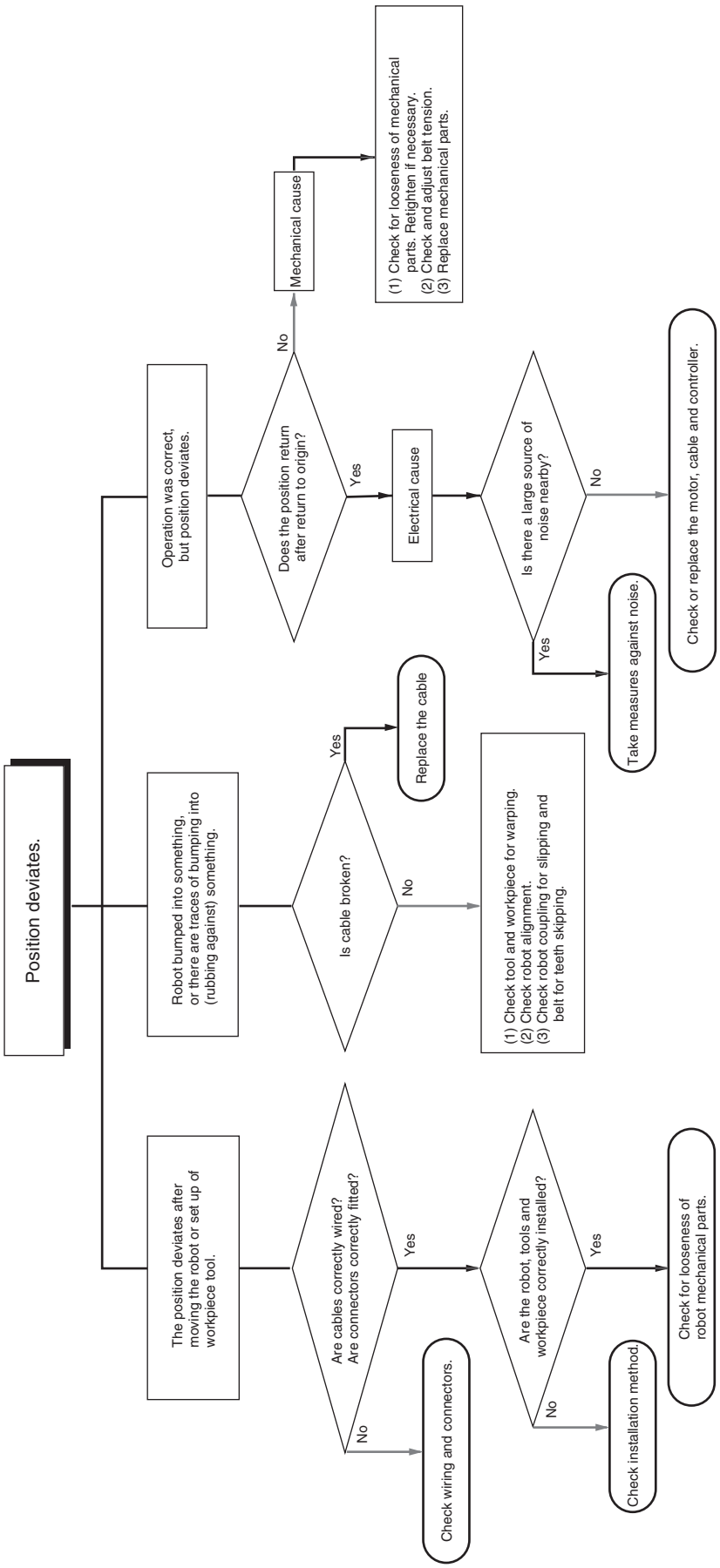
Robot	Lead length (mm)	Payload	0kg	1kg	2kg	3kg	4kg	5kg	6kg	7kg	8kg	9kg	10kg	11kg	12kg
T4P	12	Acceleration	40	40	30	25	25	20							
		Deceleration	25	25	20	15	15	10							
		Maximum speed	200	200	200	180	160	160							
	6	Acceleration	50	50	50	50	50	50	45	35	30				
		Deceleration	25	25	25	25	20	20	15	12	10				
		Maximum speed	200	200	200	200	200	180	160	160	160				
T5P	12	Acceleration	30	30	30	30	30	25	20						
		Deceleration	25	25	25	25	25	25	20						
		Maximum speed	200	200	200	180	160	160	160						
	6	Acceleration	30	30	30	30	30	30	30	30	30	30	30	30	20
		Deceleration	25	25	25	25	25	25	25	25	25	25	25	25	20
		Maximum speed	200	200	200	200	200	200	180	180	180	180	180	180	180
T5P-BK	12	Acceleration	35	25	25										
		Deceleration	25	25	25										
		Maximum speed	160	160	120										
	6	Acceleration	35	35	35	35									
		Deceleration	25	25	25	25									
		Maximum speed	160	160	140	120									

Note 1: Acceleration and deceleration units are in "61.23rad/s²".

Note 2: Maximum speed unit is in "18.75rpm".

MEMO

5-1 Positioning error


Position deviates.
Operation was correct, but position deviates.
Does the position return after return to origin?
No
Mechanical cause
(1) Check for looseness of mechanical parts. Retighten if necessary.
(2) Check and adjust belt tension.
(3) Replace mechanical parts.
Yes
Electrical cause
Is there a large source of noise nearby?
No
Check or replace the motor, cable and controller.
Yes
Take measures against noise.
Robot bumped into something, or there are traces of bumping into (rubbing against) something.
Is cable broken?
Yes
Replace the cable
No
(1) Check tool and workpiece for warping.
(2) Check robot alignment.
(3) Check robot coupling for slipping and belt for teeth skipping.
The position deviates after moving the robot or set up of workpiece tool.
Are cables correctly wired? Are connectors correctly fitted?
No
Check wiring and connectors.
Yes
Are the robot, tools and workpiece correctly installed?
No
Check installation method.
Yes
Check for looseness of robot mechanical parts.

Revision record

Manual version	Issue date	Description
Ver. 1.00	Apr. 2003	English manual Ver. 1.00 is based on Japanese manual Ver. 1.00.
Ver. 1.01	Oct. 2005	English manual Ver. 1.01 is based on Japanese manual Ver. 1.01.
Ver. 1.02	Jan. 2006	English manual Ver. 1.02 is based on Japanese manual Ver. 1.02.
Ver. 1.03	Aug. 2006	English manual Ver. 1.03 is based on Japanese manual Ver. 1.03.
Ver. 1.04	May 2007	English manual Ver. 1.04 is based on Japanese manual Ver. 1.03.

User's Manual

YAMAHA
Single-axis Robots

Pico Series
T4P/T5P

May 2007
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IM Operations

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